DOT/FAA/AM-93/4

Contribution of Personality to the Prediction of Success in Initial Air Traffic Control Specialist Training

Office of Aviation Medicine
Washington, D.C. 20591

David J. Schroeder
Dana Broach
Willie C. Young

Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

April 1993

Final Report

U.S. Department
of Transportation
**Federal Aviation
Administration**

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

Technical Report Documentation Page

1 Report No	2 Government Accession No	3 Recipient's Catalog No
DOT/FAA/AM-93/4		

4 Title and Subtitle	5 Report Date
Contributions of personality measures to predicting success of trainees in the air traffic control specialist nonradar screen program.	April 1993
	6 Performing Organization Code

7 Author(s)	8 Performing Organization Report No
David J. Schroeder, Ph.D.;Dana Broach, Ph.D.; and Willie C. Young, M.Ed.	

9 Performing Organization Name and Address	10 Work Unit No (TRAIS)
Federal Aviation Administration P.O. Box 25082 Oklahoma City, OK 73025	11 Contract or Grant No

12 Sponsoring Agency name and Address	13 Type of Report and Period Covered
Office of Aviation Medicine Federal Aviation Administration 800 Independence Avenue, S.W. Washington, DC 20591	14 Sponsoring Agency Code

15 Supplemental Notes

16 Abstract

Reviews have consistently concluded that the validity of personality as a predictor of job performance is low (Besco, 1991; Reilly & Chao, 1982; Tenopyr & Oeltjen, 1982). However, Barrick and Mount's (1991) meta-analysis of studies of personality and job performance demonstrated the utility of the "Big Five" model of personality (Digman, 1990) in personnel selection and training. This study was designed to evaluate the utility of personality in predicting student success in the FAA's Air Traffic Control Specialist (ATCS) Nonradar Screen Program ("the Screen"). The Screen follows the miniature training, testing, and evaluation paradigm (Siegel, 1983), in which individuals with no prior knowledge of the occupation are taught critical aspects of the job and then assessed on a pass/fail basis for their potential to succeed as controllers. The *NEO Personality Inventory* ("NEO-PI"; Costa & McCrae, 1985) was administered to 723 men and 307 women at entry into the 9-week Screen. NEO-PI scale scores and cognitive aptitude measures were used to predict final composite scores (COMP) of students. Men and women air traffic students exhibited lower average scores in *Neuroticism*, higher average scores in *Extroversion*, *Openness to Experience*, and *Conscientiousness*, and no difference on *Agreeableness* when compared to normative samples. Correlations between the personality scales and COMP were low for both sexes, ranging from .000 with *Impulsiveness*, a facet of *Neuroticism*, to -.148 with *Excitement-seeking*, a facet of the *Extraversion* dimension. Despite the low zero-order correlations, several of the personality facets proved useful in a regression equation, explaining an additional 3% of variance in performance over that explained by cognitive aptitude measures. These included *Excitement-seeking*, *Fantasy*, *Activity*, and *Ideas*. While these results were not entirely consistent with Barrick and Mount (1991), they do offer some support for the role of personality variables in the prediction of success in the ATCS Screen. Continued research is needed to assess the relationship of theoretically-based measures of personality to success on the job over time.

17 Key Words	18 Distribution Statement
Neuroticism, Extraversion, Openess, Agreeableness, Concientiousness, Personality, Air Traffic Control Specialist, Screen, Domain, Facet	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19 Security Classif (of this report)	20 Security Classif (of this page)	21 No of Pages	22 Price
Unclassified	Unclassified	32	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Acknowledgments

The authors gratefully acknowledge the support for data collection provided by the FAA Academy during the course of this research. The opinions expressed in this report are those of the authors and do not necessarily represent official Federal Aviation Administration policy.

A version of this paper was previously presented at the 34th Annual Meeting of the Aerospace Medical Association, Miami, FL.

Contribution of Personality to the Prediction of Success in Initial Air Traffic Control Specialist Training

The general public and the news media often ascribe personality characteristics to individuals in certain occupations. For example, the air traffic control specialist (ATCS) occupation is sometimes described in terms of personality traits such as "stress tolerant" and "attentive to detail." This ascription is sometimes extended to suggest that individuals with certain personality characteristics are attracted to specific occupations. Some research findings, such as that of Kassera and Russo (1987), provide scientific support to this lay notion of convergence between personality and occupation. Personality is also cited as an explanation for occupational performance. For example, in a review of cognitive and noncognitive factors associated with ATCS performance, Colman (1970, p. 47) noted that the "importance of personality, interest, and motivation in successful performance of air traffic control work is recognized not only by the mental health staff of the agency, but by working controllers, supervisors, personnel and general medical specialists as well." This view that personality is related to occupational choice and performance suggests two basic research questions: (a) do persons who enter the ATCS occupation differ from the general public with respect to general personality characteristics; and (b) what personality characteristics, if any, predict who is likely to become a successful controller?

Previous Research

Differences Between Controllers and General Population

Previous research is mixed on the question of personality differences between controllers and the general population. On one hand, Karson and O'Dell (1974) compared controllers (N = 11,074) and the general population using Cattell's 16PF. While most of the comparisons were statistically significant, the differences of practical significance indicated that controllers were, on the average, brighter (*B*), more conforming to the group (*G*), tough minded (*I*), practical (*M*), self-disciplined (*Q3*), and less suspicious (*L*) than the normative 16PF sample. Rose, Jenkins, and Hurst (1978) reported that results from administration of the 16PF to their sample of 388 controllers were highly similar to those noted by Karson and O'Dell. About 15 years later, Schroeder and Dollar (1989) found evidence of the same general 16PF profile for controllers as Karson and O'Dell and Rose, et al. However, the 1984 applicant group (N = 3,468) also reported less insecurity (*O*), less tension (*Q4*), and greater self-assertiveness (*E*), self-discipline (*Q3*), and emotional stability (*C*) than the 1974 controller group. Similarly, Deloney and Schroeder (1984) found differences between entry level controllers (N = 4,244) enrolled in the FAA Academy and individuals in college or other occupational settings, using the *Myers-Briggs Type Indicator* (*MBTI*; Myers, 1962). There were higher percentages of controllers classified as *Sensing-Thinking-Judging* (*ISTJ* & *ESTJ*) than among other groups.

On the other hand, Rose, Jenkins, and Hurst (1978) found little difference between controller scores (N = 391) and population norms on the *California Personality Inventory* (*CPI*; Gough, 1960). In that study, controllers were lower on *Socialization* and *Responsibility* scales than the normative group, and low average on *Self-control*, but were still within normal limits. Air traffic controllers in the field, as well as in the Academy classroom, have also been consistently reported as having lower levels of trait anxiety than individuals in other occupational groups (Collins, Schroeder, & Nye, 1991; Nye & Collins, 1991; Smith, 1985). In summary, there is some evidence that individuals attracted to the ATCS occupation differ from other, general population groups along at least some personality dimensions.

Personality and Performance

Studies finding no relationship. Several studies on the relationship of personality to ATCS training and on-the-job performance are consistent with influential reviews of the selection literature in aviation and other occupations which concluded that the validity of personality as a predictor of job performance is low, at best (Besco, 1991; Dolgin & Gibb, 1989; Guion & Gottier, 1965; Guion & Gibson, 1988; Reilly & Chao, 1982; Tenopyr & Oltjean, 1982). For example, Colman (1970) described a study conducted by Karson and O'Dell (1969) that found little evidence of any significant relationship

between scores on the 16PF and job performance ratings in the controller *Employee Appraisal Record*. Research by Schroeder (1984) using Barrett's *Impulsiveness Scale* and Manning (1984) using Zuckerman's (1979) *Sensation Seeking Scale* found little evidence for relations between those personality constructs and ATCS performance.

Studies finding some relationships. On the other hand, there are also several studies of controllers suggesting that there is a relationship between personality and ATCS performance. For example, Colman also cites work by Buckley, O'Connor, and Beebe (1969) in which statistically significant relationships between controller performance on an air traffic control simulation and 16PF scores were reported for a very small sample of 36 controllers. More recently, Collins, Nye, and Schroeder (1991) found that although entry level controllers reported significantly lower levels of anxiety on the *State-Trait Personality Inventory* (*STPI*; Speilberger, 1979), self-reported anxiety was still related to success in initial ATCS training. Individuals reporting higher levels of both state and trait anxiety experienced higher failure rates than those reporting lower levels of anxiety. In a study from the United Kingdom, Nyfield, Kandola, and Saville (1983) obtained 58 significant correlations, ranging from .16 to .31 (N = 112), between 32 *Occupational Personality Questionnaire* scores (*OPQ*; Nyfield, Kandola, & Saville, 1983) and 22 measures of ATCS job performance. Several of the correlations were related to technical proficiency (*e.g.*, ability to form a mental picture from flight progress strips only). But a majority of the correlations were with assessments of controller relationships with other personnel (e.g., cooperation from others, doesn't experience difficulty in relation to colleagues and supervisors). In Germany, the ATCS selection test battery includes personality dimensions such as *Rigidity*, *Extroversion*, and *Emotional Stability* (Fissfeldt, 1990). The validity (R) of the German battery, including personality and cognitive dimensions, with various training performance criteria ranged from .51 to .61 with sample sizes of 162 to 196 entry-level controllers. Unfortunately, component standardized regression coefficients were not reported.

Critique of past research. At the time when most of the studies just reviewed were conducted, there was little consensus on an acceptable taxonomy for classifying personality traits in such a way as to determine if there were consistent, meaningful relationships between particular personality constructs and job performance measures across tests and across or within occupations (Mount & Barrick, 1991). Recent meta-analyses of a large number of personality-oriented validation studies by Barrick and Mount (1991) and Tett, Jackson, and Rothstein (1991) demonstrated the utility of the "Big Five" model of personality in the prediction of various job performance criteria across many occupations. This model of personality suggests that there are five major factors of personality as described by factor and structural analyses of the domain of trait labels people use to describe themselves and others (Digman, 1990; Hofstee, 1984; Hogan, 1983; John, Angleitner, & Ostendorf, 1988; Norman, 1963; Tupes & Christal, 1961). Tett, et al., obtained a corrected estimate of the overall relation between "Big Five" personality dimensions and job performance measures of .24, indicating that personality may have utility in the prediction of job performance. This line of research on the validity and utility of the "Big Five" model of personality is extended to the ATCS occupation in this study. Our specific purposes were (a) to investigate the differences, if any, between entry-level controllers and normative samples, and (b) to assess the incremental validity of a "Big Five" measure of personality over cognitive aptitude in the prediction of performance in initial ATCS training at the FAA Academy.

METHOD

Sample

Subjects for this study were drawn from students enrolled in the FAA Academy ATCS Nonradar Screen program between September, 1990 and May, 1991. Complete personality, aptitude, and training performance data were obtained for a total of 1,121 first-time entrants. Sample demographic characteristics are presented in Table 1 in comparison to the population of FAA Academy entrants. The sample was composed mostly of non-minority men with some college education with an average age of 26 (range from 18 to 32); the majority reported some college education. As shown in Table 1, this sample of entry-level controllers was typical of the population of Academy entrants.

Table 1

Sample and Population Demographic Characteristics of ATCS Students

Characteristic	Category	Population (N = 9,945)	Sample (N = 1,091)
Sex	Men	81.1% (8,065)	64.5% (723)
	Women	18.9% (1,880)	27.4% (307)
	Missing		8.1% (91)
Ethnicity	White	87.0% (8,650)	73.7% (826)
	Asian	1.1% (113)	2.3% (26)
	Native American	0.6% (62)	0.7% (8)
	African American	5.0% (502)	9.5% (106)
	Hispanic Non-white	3.4% (340)	4.6% (52)
	Unknown	2.8% (278)	9.2% (103)
Age	Mean	26.1	26.3
	SD	4.9	3.0

Measures

The NEO Personality Inventory

The *NEO Personality Inventory* (NEO-PI; Costa & McCrae, 1985) is one of the first personality inventories designed to explicitly assess the five major personality dimensions identified over the course of more than 50 years of factor analytic research. The NEO-PI was developed through a series of overlapping factor analyses, longitudinal studies, and peer rating studies, using samples of adult men and women rather than just college students. This research program is described by Costa and McCrae (1985; 1987, 1988a). The normative samples consisted of 502 men, ranging in ages from 21 to 93, and 481 women, aged 19 to 93. Estimates for coefficients of reliability for the scales range from .85 to .93; those for test-retest reliability range from .86 to .91 (Costa & McCrae, 1985, 1988b). The five primary scales comprising the NEO-PI are: *Neuroticism* (*N*); *Extraversion* (*E*); *Openness to experience* (*O*); *Agreeableness* (*A*); and *Conscientiousness* (*C*). Each of the *N*, *E*, and *O* domain scales are composed of six subscales assessing specific facets of each domain. As a result, meaningful individual differences can be seen within domains, providing a more fine-grained analysis of persons or groups. Domain and facet scales descriptions are presented in Table 2.

Aptitude

A written aptitude test is administered by the U.S. Office of Personnel Management (OPM) as the first hurdle to entering the ATCS occupation. The OPM ATCS written civil service examination battery is composed of three tests: (a) the *Multiplex Controller Aptitude Test* (MCAT); (b) a test of Abstract Reasoning (ABSR); and (c) an *Occupational Knowledge Test* (OKT). The general development, psychometric characteristics, and validity of this test battery are described by Sells, Dailey, and Pickrel (1984). Extensive research conducted by the Civil Aeromedical Institute indicates that scores on the civil service test battery are significantly correlated with student performance in the FAA Academy ATCS Screen program (Manning, Della Rocco, & Bryant, 1989; Rock, Dailey, Ozur, Boone, & Pickerel, 1981). Results from the test battery are combined with any statutory veteran's preference to yield a final civil service rating (RATING). This rating is used to rank-order ATCS job applicants

within statutory guidelines such that hiring is done on the basis of merit, as more fully described in Aul (1991).

Criterion

The FAA Academy Nonradar Screen. The FAA Academy Nonradar Screen ("the Screen") was established in response to recommendations made by the U.S. 94th Congress House Committee on Government Operations (U.S. Congress, 1976) to reduce field training attrition rates. The most recent version of the Screen was implemented in October 1985, supplanting predecessor, option-specific (Terminal and En Route) programs in place from 1976 through 1985. This Screen was revised again in 1986, shortening the course from 60 to 42 working days; the program remained relatively stable in content and process until it was terminated in March, 1992. The Screen was based upon a miniaturized training-testing-evaluation personnel selection model (Siegel, 1978, 1983; Siegel & Bergman, 1975) in which individuals with no prior knowledge of the occupation could be assessed for their potential to succeed in air traffic control.

Performance measures. The Screen was developed with a clear emphasis on the assessment of developmental performance using multiple methods (Boone, 1984). As a result, thirteen assessments of performance were made during the Screen (Della Rocco, Manning, & Wing, 1990). These measures were derived from tests administered in the classroom, observed performance during laboratory simulations of non-radar air traffic control, and a final written examination. The measures were summed and weighted to create a final composite Screen score (COMP), ranging from a theoretical minimum of 12 to a maximum of 100. A minimum score of 70 was required to pass the Screen. Failure in the Screen resulted in the removal of the student from the ATCS occupational series at the very least, and often in termination from employment with the FAA. The final composite score (COMP) was the training performance criterion of interest in this study.

Procedure

Comparison to norms

Three analytic procedures were employed to explore possible differences between persons entering the ATCS occupation and the general population. First, mean scores for the sample of entry-level controllers on the main and facet scales of the NEO-PI were compared with the published norms. The null hypothesis that there were no differences between entry-level controllers and normative groups was tested by t test computed on the pooled variances of the groups. The overall risk of Type I errors across the multiple comparisons was minimized through the use of an unordered Bonferonni procedure (Rosenthal & Rubin, 1984). The corrected criterion α for any given t test was .004, based on 12 comparisons for each sex. Second, mean differences were translated into Common Language Effect Sizes (*CL*; McGraw & Wong, 1992) as an aid to clarifying the practical significance of any differences. The *CL* metric for effect size is the number of times out of 100 that a randomly sampled entry level controller (group 1) will have a higher score on a given personality scale than a randomly sampled person from the general (normative) population (group 2). For example, if $CL = 68$ with respect to the *Extraversion* domain scale of the NEO-PI, we would expect that, for any random pairing of a controller with a member of the general normative population, the controller would have the higher score 2 out of 3 times. A *CL* of 50 suggests that compared to a normative sample controllers would be no more likely to have higher scores on a scale than might be expected by chance alone. The third analytic procedure illustrates these mean differences and effect sizes in terms of the degree or percent of overlap in the distribution of scale scores for the controllers and normative groups. The greater the amount of overlap, as indicated by Tilton's *O* (1937) statistic, the less effective a scale is in separating or discriminating between the two distributions. Taken together, these three analytic procedures provided information about potential differences between entry-level controllers and members of the normative populations.

Table 2

NEO-PI Domain and Facet Scale Interpretations

Low Scores	Scale	High Scores
Calm, stable, relaxed, secure, deliberate	*NEUROTICISM (N)*	Worried, tense, unstable, nervous, impulsive
Relaxed, calm	*Anxiety (N1)*	Fearful, worried
Amiable, even-tempered	*Hostility (N2)*	Angry, easily-frustrated
Hopeful, feels worthwhile	*Depression (N3)*	Guilty, hopeless
Secure, comfortable	*Self-consciousness (N4)*	Ashamed, easily embarrassed
Self-controlled	*Impulsiveness (N5)*	Impulsive, unable to resist
Resilient, hardy	*Vulnerability (N6)*	Intolerant of stress
Reserved, aloof, quiet, reticent	*EXTRAVERSION (E)*	Outgoing, gregarious, talkative, energetic
Cold, formal	*Warmth (E1)*	Talkative, affectionate
Solitary, self-contained	*Gregariousness (E2)*	Convivial
Unassuming, retiring	*Assertiveness (E3)*	Dominant, forceful
Slow, deliberate	*Activity (E4)*	Energetic, vigorous
Cautious, staid	*Excitement-seeking (E5)*	Flashy, takes risks
Unenthusiastic, serious	*Positive Emotions (E6)*	Cheerful, high-spirited
Unlearned, realistic, pragmatic, dogmatic	*OPENNESS TO EXPERIENCE (O)*	Inquiring, analytical, tolerant, curious
Realistic, practical	*Fantasy (O1)*	Imaginative
Insensitive to art and beauty	*Aesthetics (O2)*	Moved by art and beauty
Narrow range of emotions	*Feelings (O3)*	Empathic, values feelings
Prefers familiar, routine	*Actions (O4)*	Prefers new, novel
Pragmatic, factual	*Ideas (O5)*	Curious, analytical
Dogmatic, conservative	*Values (O6)*	Tolerant, non-conforming
Cynical, rude, ruthless, uncooperative	*AGREEABLENESS (A)*	Trusting, helpful, forgiving, gullible
Unreliable, disorganized, negligent	*CONSCIENTIOUSNESS (C)*	Organized, reliable, punctual, obedient

Table 3

Comparison of Men Controller NEO-PI Domain Scale Scores to Adult and College Men Norms

	ATCS (N = 723)		Adult Men (N = 502)				College Men (N = 250)			
Domain Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
Neuroticism	64.6	19.1	73.0	19.3	- 7.54***	9	86.1	21.1	-14.93***	1
Extraversion	121.7	16.8	102.6	18.0	19.00***	99	116.6	16.8	4.14***	81
Openness	113.0	15.8	109.2	17.4	3.97***	75	121.9	19.9	- 7.16***	7
Agreeableness	48.3	7.0	48.4	6.1	- .26	49	45.3	7.2	5.80***	79
Conscientious	52.9	8.0	49.8	8.2	6.60***	78	44.1	8.8	14.60***	98

NOTES: *CL* = Common Language Effect Size, or number times that men controllers expected to have higher scores than normative sample in 100 random pairings

***$p \leq .004$

Prediction of performance

Zero-order correlations between the final OPM rating at hire (RATING), personality facet and domain scale scores, and final Screen composite score (COMP) were computed. These correlations were *not* corrected for direct and incidental restriction in range due to selection of subjects on the OPM rating at hire. Therefore, the estimates from this analysis represent lower-bound estimates of the relationships between aptitude, personality, and performance in the general population. Blockwise multiple regression analysis was used to assess the incremental validity of the personality scales over that of the aptitude measure in the prediction of performance in the FAA Academy ATCS Screen program. The OPM rating at hire was entered into the regression equation in the first block in order to identify the proportion of variance in Screen performance accounted by cognitive aptitude. The personality *N*, *E*, and *O* facet scales and *A* and *C* domain scales were examined in the second block using stepwise regression. Use of this procedure provided an assessment of the additional significant variance in Screen performance accounted for by personality beyond that already accounted for by the general cognitive aptitude measure. The null hypothesis was that personality measures would not account for additional variance in Screen performance beyond that accounted for OPM rating.

RESULTS

Comparison to norms

Men

Domain scales. Means and standard deviations for the NEO-PI domain scale scores for the men ATCS students, adult men, and college men are presented in Table 3. While there appeared to be some degree of overlap between entry-level controllers and both adult and college men normative distributions (Table 4), the *t* tests and *CL* effect sizes, using a criterion of $CL \leq 25$ or ≥ 75, indicated important differences between the groups in the overall profiles. ATCSs differed significantly from adult men on 4 of the 5 domain scales (all except *Agreeableness*) and from college men on each of the domains. As a group, ATCSs reported significantly lower ($p \leq .004$) neuroticism than the adult or college men. The *CL* suggest that 9 or fewer entry-level controllers might be expected to have higher *N* scores than normative adult or college men in 100 random pairings. ATCSs were also more extroverted and conscientious than either adult men or college men, with far more controllers expected to have higher *E* and *C* scores than normative men in 100 random pairings.

On the *Openness to Experience* dimension, ATCSs had higher scores than adult men ($p \leq .004$) but lower than

Table 4

Percentage Overlap (Tilton's O) in Controller and Normative Distributions for Men on NEO-PI Domain Scales

Domain Scale	Overlap of ATCS Men with Adult Men (N = 502)	College Men (N = 250)
Neuroticism	82%	59%
Extraversion	56%	88%
Openness	91%	80%
Agreeableness	99%	83%
Conscientiousness	84%	60%

Table 5

Comparison of Men Controller Neuroticism Facet Scores to Adult and College Men Norms

	ATCS (N = 723)		Adult Men (N = 502)				College Men (N = 250)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
N1)Anxiety	12.5	4.5	12.8	5.2	- 1.08	46	15.3	4.8	- 8.33***	18
N2)Hostility	9.4	4.4	10.7	4.4	- 5.08***	33	12.7	5.1	- 9.80***	14
N3)Depress.	9.3	4.5	11.5	5.0	- 8.04***	24	14.0	5.3	-13.58***	7
N4)S-Consc.	12.6	4.4	13.6	4.1	- 4.02***	37	15.2	4.5	- 8.01***	19
N5)Impulsive	14.0	4.3	14.9	4.2	- 3.64***	38	17.9	4.7	-12.06***	10
N6)Vulnerable	6.9	3.6	9.5	3.5	-12.57***	17	10.9	4.0	-14.70***	7

NOTES: *CL* = Common Language Effect Size, or number of times that men controllers expected to have higher scores than normative samples in 100 random pairings

***$p \leq .004$

Table 6

Percentage Overlap (Tilton's O) in Controller and Normative Distributions for Men on NEO-PI Facet Scales

FACET	Overlap of Men ATCS Students with Adult Men (N = 502)	College Men (N = 250)
	NEUROTICISM	
Anxiety	96%	76%
Hostility	88%	73%
Depression	82%	62%
Self-Consciousness	90%	77%
Impulsiveness	91%	66%
Vulnerability	71%	60%
	EXTRAVERSION	
Warmth	86%	86%
Gregariousness	77%	99%
Assertiveness	81%	79%
Activity	73%	87%
Excitement-Seeking	46%	99%
Positive Emotions	68%	100%
	OPENNESS	
Fantasy	94%	70%
Aesthetics	93%	74%
Feelings	88%	83%
Actions	95%	68%
Ideas	80%	89%
Values	97%	94%

college men ($p \leq .004$). Average ATCS scores on the *A* scale did not differ from those of adult men but were higher than those of college men ($p \leq .004$).

Facet scales. Comparisons of the average ATCS men's scores on the 6 *N* facet scales with those of the two normative groups appear in Table 5, with overlap in distributions presented in Table 6. The pattern of scores for the three groups was consistent on each of the 6 facets, except for *Anxiety*. That was the only facet on which scores for ATCS men and adult men did not significantly differ. Otherwise, college men had generally higher average scores on the *N* facets, adult men were in the middle, and men controllers had lower average scores. As shown in Table 6, there was less overlap between entry-level controller and college men distributions than with adult men. Means, standard deviations, results of the *t* tests and *CL* estimates for the three men's groups on the 6 *E* facet subscales are presented in Table 7. Mean scores for men controllers were significantly higher than for adult men on each of the six *E* facets ($p \leq .004$). However, controllers differed from their college counterparts on only the *Warmth*, *Assertiveness*, and *Activity* facets, with controllers presenting higher mean scores. Overall, the effect sizes in Table 7 and overlap indices presented in

Table 7

Comparison of Men Controller Extraversion Facet Scores to Adult and College Men Norms

	ATCS (N = 723)		Adult Men (N = 502)				College Men (N = 250)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
E1)Warmth	23.6	4.1	22.2	3.9	5.99***	69	22.1	4.1	4.99***	70
E2)Gregarious	17.3	4.5	14.8	4.3	9.74***	80	17.2	4.8	.30	51
E3)Assertive	18.8	4.1	16.7	4.6	8.38***	76	16.6	4.3	7.22***	78
E4)Activity	19.0	3.9	16.1	4.5	12.01***	84	17.7	4.3	4.42***	67
E5)Excitement	21.6	4.3	15.0	4.7	25.42***	99	21.5	4.1	.32	51
E6)Emotions	21.5	4.2	17.9	4.6	14.18***	89	21.5	4.3	0.00	50

NOTES: *CL* = Common Language Effect Size, or number of times men controllers expected to have higher scale scores than normative samples in 100 random pairings

***$p \leq .004$

Table 8

Comparison of Men Controller Openness to Experience Facet Scores to Adult and College Men Norms

	ATCS (N = 723)		Adult Men (N = 502)				College Men (N = 250)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
O1)Fantasy	17.3	4.7	16.5	5.0	2.85	60	21.0	4.9	-10.61***	12
O2)Aesthetics	15.8	5.7	16.8	5.2	-3.13	38	19.5	5.6	- 8.89***	14
O3)Feelings	20.7	4.0	19.5	3.9	5.22***	67	22.5	4.2	- 6.05***	17
O4)Actions	16.1	3.5	15.7	3.7	1.92	56	16.4	3.6	- 1.16	46
O5)Ideas	22.0	4.6	19.6	4.9	8.74***	78	20.6	5.5	3.94***	67
O6)Values	21.2	4.4	20.9	4.1	1.21	54	21.9	4.1	- 2.20	41

NOTES: *CL* = Common Language Effect Size, or number of times men controllers expected to have higher scale scores than normative samples in 100 random pairings

***$p \leq .004$

Table 9

Comparison of Women Controller NEO-PI Domain Scale Scores to Adult and College Women Norms

	ATCS (N = 307)		Adult Women (N = 481)				College Women (N = 276)			
Domain Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
Neuroticism	66.3	20.2	80.7	23.3	-8.90***	1	94.9	21.2	-16.67***	1
Extraversion	124.5	17.0	105.5	16.4	15.63***	99	114.9	17.4	6.73***	95
Openness	118.2	15.8	115.3	18.3	2.28	69	123.4	17.2	- 3.80***	18
Agreeableness	51.0	6.6	51.5	5.9	- 1.11	44	49.1	7.0	3.37***	70
Conscientious	55.2	7.6	50.3	8.8	8.03***	89	45.7	9.2	13.64***	99

NOTES: *CL* = Common Language Effect Size, or number of times controllers expected to have higher domain scale scores than normative sample in 100 random pairings

***$p \leq .004$

Table 10

Percentage Overlap (Tilton's O) in Controller and Normative Distributions for Women on NEO-PI Domain Scales

Domain Scale	Overlap of Women ATCS Students with Adult Women (N = 481)	College Women (N = 276)
Neuroticism	74%	49%
Extraversion	57%	78%
Openness	93%	87%
Agreeableness	97%	89%
Conscientiousness	77%	57%

Table 6 suggested that entry-level controllers were more similar to college men in the *E* domain than to adult men. Means, standard deviations, *t* tests, and *CL* estimates for the *O* facet subscales are presented in Table 8. Average scores for ATCS men were significantly higher than those of adult men on the *Feelings* ($p \leq .004$) and *Ideas* ($p \leq .004$) facets. Men controllers differed significantly from college men on each of the *O* facets except *Actions* and *Values*. Compared to the ATCS men, college men were higher on *Fantasy*, *Aesthetics*, and *Feelings*, but lower on *Ideas*. Overall, the pattern of *CL* effect size estimates and overlap in distributions suggested that entry-level controllers were more similar to adult men in terms of their openness to experience than they were to college men.

Women

Domain scales. Comparisons of the means and standard deviations for women ATCSs, adult women, and college women on the 5 NEO-PI domains appear in Table 9. Estimates of the degree of overlap between controller and normative score distributions are presented in Table 10 for the domain scales. Scores for ATCS women differed significantly from those of adult women on 3 of the 5 dimensions and from college women on each of the 5 dimensions. Women entry controllers did not differ from adult women on the *Agreeableness* and *Openness* domain scales. In comparison to adult women, ATCSs reported less neuroticism and greater extraversion, openness, and conscientiousness. They also appeared to have less neuroticism and openness than college women. Women ATCSs were more extraverted and exhibited higher agreeableness and conscientiousness scores than did their college counterparts. Overall, the pattern of effect sizes and degree of overlap between distributions (Table 10) suggested that entry-level women controllers were more similar to adult women than they were to college-aged women.

Facet scales. Table 11 presents the means, standard deviations and *t* test comparisons for the three groups on the 6 *Neuroticism* facet subscales. ATCS women had significantly lower scores ($p \leq .004$) than either adult women or college women on 5 of the 6 *N* facets; women controllers and adult women did not differ on the *Impulsive* facet. The pattern of scores for the three groups was similar to that noted for men, ATCS women had the lowest scores, adult women were in between, and college women had the highest scores. Overall, the pattern of overlap between distributions (Table 12) and *CL* effect sizes suggested that entry-level women controllers were

Table 11

Comparison of Women Controller Neuroticism Facet Scores to Adult and College Women Norms

	ATCS (N = 307)		Adult Women (N = 481)				College Women (N = 276)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
N1)Anxiety	13.0	4.5	15.4	5.9	- 6.09***	23	18.2	5.1	-13.08***	5
N2)Hostility	9.1	4.2.	10.3	4.5	- 3.74***	34	12.8	5.0	- 9.70***	11
N3)Depress.	9.2	4.9	13.2	6.0	- 9.78***	11	15.7	6.0	-14.38***	2
N4)S-Consc.	12.4	4.4	14.6	4.8	- 6.48***	24	16.6	4.7	-11.14***	8
N5)Impulsive	15.1	4.9	16.1	4.7	- 2.86	37	18.8	4.4	- 9.55***	11
N6)Vulnerable	7.5	3.6	11.2	4.0	-13.16***	8	12.8	4.4	-15.98***	3

NOTES: *CL* = Common Language Effect Size, or number of times women controllers expected to have higher scale score than normative samples in 100 random pairings

***$p \leq .004$

Table 12

Percentage Overlap (Tilton's O) in Controller and Normative Distributions for Women on NEO-PI Facet Scales

Facet Scale	Overlap of ATCS Women with Adult Women (N = 481)	Overlap of ATCS Women with College Women (N = 276)
	NEUROTICISM	
Anxiety	82%	59%
Hostility	89%	68%
Depression	71%	55%
Self-Consciousness	81%	64%
Impulsiveness	91%	84%
Vulnerability	63%	51%
	EXTRAVERSION	
Warmth	92%	78%
Gregariousness	82%	98%
Assertiveness	76%	71%
Activity	75%	79%
Excitement-Seeking	41%	99%
Positive Emotions	72%	88%
	OPENNESS	
Fantasy	98%	72%
Aesthetics	86%	77%
Feelings	93%	82%
Actions	88%	92%
Ideas	78%	86%
Values	87%	93%

more similar to adult women in terms of the *N* domain and its facets than they were to college women. Comparisons of the means and standard deviations for the three women groups on the *Extraversion* facet subscales are presented in Table 13. Average scores for women ATCSs were significantly higher than those of the adult women on 5 of the 6 *E* facet subscales and higher than those of college women on 4 of the 6 subscales. The largest mean difference occurred on the *Excitement-seeking* (E5) subscale (20.3 for ATCSs versus 12.9 for adult women); women controllers would be expected to have higher E5 scores than adult women in 99 out of 100 random pairings. In general, the pattern of overlap between controller and normative sample distributions on the *E* facet scales (Table 12) suggested that women controllers were more similar to college women than adult women in terms of their extraversion. Finally, facet scores for the *O* domain subscales are compared in Table 14. Women controllers had significantly higher scores than adult women on the *Ideas* and *Values* facets. The *CL* effect size estimates indicated that, on the average, women controllers would be expected to have higher scores on these facets than would adult women. On the other hand, women controllers would be expected to have lower

Table 13

Comparison of Women Controller Extraversion Facet Scores to Adult and College Women Norms

	ATCS (N = 307)		Adult Women (N = 481)				College Women (N = 276)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
E1)Warmth	24.5	3.9	23.8	3.6	2.58	60	22.4	3.7	6.65***	78
E2)Gregarious	17.9	4.6.	15.9	4.3	6.19***	75	17.6	4.6	.78	54
E3)Assertive	19.0	4.7	16.1	4.9	8.23***	82	15.5	4.9	8.80***	87
E4)Activity	19.8	4.3	16.9	4.6	8.85***	83	17.5	4.5	6.30***	78
E5)Excitement	20.3	4.6	12.9	4.4	22.62***	99	20.2	4.7	.26	51
E6)Emotions	23.1	4.0	20.0	4.6	9.70***	86	21.8	4.6	3.65***	67

NOTES: *CL* = Common Language Effect Size, or number of times that women controllers expected to have higher scale scores than normative sample in 100 random pairings

***$p \leq .004$

Table 14

Comparison of Women Controller Openness to Experience Facet Scores to Adult and College Women Norms

	ATCS (N = 307)		Adult Women (N = 481)				College Women (N = 276)			
Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*	*M*	*SD*	*t*	*CL*
O1)Fantasy	17.2	5.0	17.0	5.3	.53	52	20.7	4.7	-8.68***	13
O2)Aesthetics	17.8	5.2	19.6	5.4	-4.63***	29	20.9	5.5	-6.99***	17
O3)Feelings	22.5	3.8	21.8	4.2	2.37	60	24.2	3.7	-5.46***	27
O4)Actions	17.2	3.7	17.3	3.8	- .36	48	16.4	3.8	2.57	61
O5)Ideas	21.3	4.7	18.6	5.0	7.56***	81	19.5	5.3	4.35***	72
O6)Values	22.3	3.8	21.0	4.3	4.33***	68	21.7	3.4	2.00	59

NOTES: *Cl* = Common Language Effect Size, or number of times women controllers expected to have higher scale scores than normative samples in 100 random pairings

***$p \leq .004$

Table 15

NEO-PI Domain and Facet Scale Scores for Controllers by Sex

	Male ATCS (N = 723)		Female ATCS (N = 307)			
DOMAIN/Facet Scale	*M*	*SD*	*M*	*SD*	*t*	*CL*
NEUROTICISM	64.6	19.1	66.3	20.2	-1.28	39
N1)Anxiety	12.5	4.5	13.0	4.5	-1.63	43
N2)Hostility	9.4	4.4	9.1	4.2	1.01	54
N3)Depression	9.3	4.5	9.2	4.9	0.32	51
N4)Self-consciousness	12.6	4.4	12.4	4.4	0.67	53
N5)Impulsive	14.0	4.3	15.1	4.9	-3.60***	36
N6)Vulnerability	6.9	3.6	7.5	3.6	-2.45	41
EXTRAVERSION	121.7	16.8	124.5	17.0	-2.44	33
E1)Warmth	23.6	4.1	24.5	3.9	-2.44	38
E2)Gregariousness	17.3	4.5	17.9	4.6	-1.94	42
E3)Assertiveness	18.8	4.1	19.0	4.7	-0.68	47
E4)Activity	19.0	3.9	19.8	4.3	-2.92	39
E5)Excitement-seeking	21.6	4.3	20.3	4.6	4.34***	67
E6)Positive Emotions	21.5	4.2	23.1	4.0	-5.67***	29
OPENNESS	113.0	15.8	118.2	15.8	-4.83***	18
O1)Fantasy	17.3	4.7	17.2	5.0	0.31	51
O2)Aesthetics	15.8	5.7	17.8	5.2	-5.28***	28
O3)Feelngs	20.7	4.0	22.5	3.8	-6.70***	26
O4)Actions	16.1	3.5	17.2	3.7	-4.53***	34
O5)Ideas	22.0	4.6	21.3	4.7	2.22	41
O6)Values	21.2	4.4	22.3	3.8	-3.82***	35
AGREEABLENESS	48.3	7.0	51.0	6.6	-5.76***	23
CONSCIENTIOUSNESS	52.9	8.0	55.2	7.6	-4.28***	28

NOTES: *CL* = Common Language Effect Size, or number of times that men would have higher scores than women in 100 random pairings

***$p \leq .004$

scores on the *Aesthetics* facet than would adult women. In contrast, women controllers differed significantly from college women on 4 of the 6 *O* facet scales. Women controllers were more likely to have lower scores than college women on the *Fantasy*, *Aesthetics*, and *Feelings* facets, and higher scores on the *Ideas* facet. Overall, the pattern of overlap and effect sizes suggested that women controllers were more similar to adult women on the first three facets (*Fantasy*, *Aesthetics*, and *Feelings*) and more similar to college women on the *Actions*, *Ideas*, and *Values* facets.

Comparison of Men and Women Controllers

Means and standard deviations for the NEO-PI domain and facet scales for men and women ATCS students are presented in Table 15. While there was some degree of overlap between the sexes, the *t* tests and *CL* effect sizes revealed that men and women differed significantly and practically on 3 of the 5 domain scales. Women ATCSs had higher scores than men on the *O*, *A*, and *C* domain scales ($p \leq .004$). The higher *O* scores for women ATCS students were consistent with sex differences reported by Costa and McCrae (1989). Averages for women were also higher than men on the *N* and *E* domain scales, but did not meet the practical cutoff of $25 \leq CL \geq 75$. None of the differences noted on the facet scales between men and women met the stipulated cutoff for practical significance, although there were several statistically significant differences of interest. For example, men were less impulsive (N5) and reported less positive emotions (E6) than women controllers ($p \leq .004$), but sought more excitement (E5). Women had higher scores, on the average, than men controllers on 4 of the 6 *Openness* facet scales: *Aesthetics* (O2), *Feelings* (O3), *Actions* (O4), and *Values* (O6). Overall, men and women entry-level controllers appeared to have quite similar profiles, with women generally having just slightly elevated scores over men.

Prediction of Performance

Correlations

Zero order correlations between the measure of cognitive aptitude (RATING) for the ATCS occupation, NEO-PI facet and domain scale scores, and final composite score (COMP) in the screen for both men ($N = 529$) and women ($N = 193$) cases with complete valid data are presented in Tables 16 and 17. Correlations between aptitude (RATING) and personality scores for men ranged from a low of .000 with *Impulsive* (N5) to an absolute maximum of .098 with the *Ideas* (O5) facet. Correlations between aptitude and personality scores for women were similarly low, ranging from .002 with *Fantasy* (O1) to a high of .169 with *Values* (O6). Correlations between the personality measures and Academy screen score (COMP) for men were also low, ranging from -.005 for *Aesthetics* (O2) to -.148 with the facet *Excitement-seeking* (E5). The pattern of correlations between personality and performance for women was very similar, with generally low correlations ranging from -.005 with *Assertiveness* (E3) to .178 with *Ideas* (O5).

Regression

Results of the regression analysis to determine if the personality variables contributed to the prediction of Academy Screen performance above that contributed by cognitive aptitude are presented in Table 18 by sex. The results suggested that the null hypothesis should be rejected for both men and women controllers. There was a small, but significant increase in incremental validity for men when personality variables entered the prediction equation ($\Delta R^2 = .033$, $\Delta F\ (4,524) = 3.84$, $p \leq .05$). The significant personality factors included the *Fantasy* (01), *Excitement-seeking* (E5), and *Activity* (E4) facets. However, the total percentage of explained variance that those three variables added was quite small (3%). Just one facet, *Ideas* (O5), entered the stepwise regression solution for women, after entering aptitude into the prediction equation ($\Delta R^2 = .028$, $\Delta F(2,190) = 5.53$, $p \leq .05$). As with men, personality accounted for a bare 3% of additional explained variance in performance above that already explained by cognitive aptitude.

Table 16

Zero-Order Correlations Between Cognitive Aptitude (RATING), NEO-PI Facet and Domain Scale Scores, and Final Screen Composite Score (COMP) for Men (N=529)

	RATING	N1	N2	N3	N4	N5	N6	E1	E2	E3	E4	E5	E6	O1	O2	O3	O4	O5	O6	A	C	COMP
N1	-.035																					
N2	.011	.463																				
N3	-.017	.633	.438																			
N4	.000	.545	.387	.555																		
N5	.027	.404	.395	.422	.390																	
N6	-.010	.603	.462	.610	.551	.362																
E1	-.097	-.195	-.424	-.302	-.313	-.156	-.301															
E2	-.083	-.103	-.244	-.164	-.247	-.104	-.124	.560														
E3	-.046	-.324	-.132	-.405	-.475	-.169	-.437	.364	.342													
E4	-.018	-.160	-.030	-.221	-.183	-.058	-.281	.216	.120	.414												
E5	-.070	-.072	-.005	-.102	-.176	.140	-.184	.299	.338	.293	.292											
E6	-.084	-.116	-.248	-.222	-.185	-.022	-.254	.496	.314	.300	.283	.337										
O1	.047	.273	.132	.278	.194	.378	.178	-.015	-.015	-.145	-.038	.151	.185									
O2	-.049	.152	-.062	.062	-.078	-.021	.043	.144	.092	.001	.013	.124	.176	.222								
O3	-.031	.121	-.059	-.021	-.019	.059	-.076	.379	.193	.183	.203	.187	.379	.199	.342							
O4	-.003	-.174	-.137	-.120	-.297	-.081	-.199	.138	.084	.121	.068	.061	.088	.057	.135	.039						
O5	.098	-.156	-.263	-.180	-.236	-.132	-.306	.223	.062	.180	.195	.197	.286	.141	.374	.261	.289					
O6	.011	-.072	-.143	-.137	-.157	.071	-.249	.117	.099	.116	.040	.251	.208	.178	.113	.136	.238	.269				
A	-.037	-.208	-.540	-.264	-.196	-.309	-.330	.570	.244	.031	.044	.019	.350	-.100	.111	.240	.161	.231	.145			
C	-.011	-.327	-.369	-.446	-.294	-.406	-.512	.306	.139	.339	.434	.132	.244	-.267	.010	.170	-.017	.228	.022	.295		
COMP	.230	.034	.018	.024	.063	.048	.062	-.065	-.025	-.081	.028	-.148	-.070	.082	-.005	.026	.068	.061	.029	.013	-.069	
M	94.74	12.40	9.38	9.26	12.60	14.20	6.91	23.54	17.40	18.84	19.07	21.58	21.48	17.36	15.66	20.61	16.23	21.92	21.28	48.32	52.73	73.15
SD	5.05	4.53	4.44	4.81	4.39	4.25	3.49	4.06	4.50	4.11	3.80	4.35	4.20	4.65	5.56	3.93	3.41	4.58	4.31	6.81	8.03	12.19

NOTES: N1 = Anxiety; N2 = Hostility; N3 = Depression; N4 = Self-consciousness; N5 = Impulsiveness; N6 = Vulnerability; E1 = Warmth; E2 = Gregariousness; E3 = Assertiveness; E4 = Activity; E5 = Excitement-seeking; E6 = Positive Emotions; O1 = Fantasy; O2 = Aesthetics; O3 = Feelings; O4 = Actions; O5 = Ideas; O6 = Values; A = Agreeableness; C = Conscientiousness

Table 17

Zero-Order Correlations Between Cognitive Aptitude (RATING), NEO-PI Facet and Domain Scale Scores, and Final Screen Composite Score (COMP) for Women (N=193)

	RATING	N1	N2	N3	N4	N5	N6	E1	E2	E3	E4	E5	E6	O1	O2	O3	O4	O5	O6	A	C	COMP
N1	.050																					
N2	.023	.448																				
N3	.167	.616	.497																			
N4	.111	.557	.334	.654																		
N5	.049	.460	.426	.559	.441																	
N6	.089	.631	.423	.646	.550	.463																
E1	-.023	-.135	-.380	-.242	-.297	-.124	-.242															
E2	-.083	-.124	-.229	-.165	-.204	-.075	-.181	.494														
E3	-.105	-.331	-.106	-.342	-.427	-.226	-.360	.322	.331													
E4	.050	-.186	-.124	-.343	-.251	-.276	-.460	.188	.234	.463												
E5	.033	.032	.073	-.015	-.080	.084	-.111	.213	.276	.234	.338											
E6	-.060	-.179	-.280	-.343	-.332	-.095	-.368	.590	.351	.341	.394	.375										
O1	.002	.255	.152	.246	.066	.365	.221	.152	-.013	-.141	-.236	.169	.227									
O2	.004	.116	-.122	.055	.014	-.025	.048	.203	-.042	.033	-.009	.140	.259	.342								
O3	-.029	.075	.033	-.137	-.078	.027	-.193	.434	.201	.270	.247	.272	.502	.343	.227							
O4	-.018	-.180	-.111	-.173	-.280	-.120	-.093	.061	.141	.102	-.011	.138	.150	.245	.121	-.024						
O5	.085	-.107	-.113	-.116	-.186	-.165	-.268	.176	-.001	.302	.246	.137	.276	.136	.409	.299	.147					
O6	.169	-.118	-.063	-.118	-.202	-.001	-.212	.172	.024	.137	.251	.218	.220	.182	.065	.257	.197	.271				
A	.060	-.206	-.560	-.279	-.187	-.233	-.340	.524	.246	.049	.088	-.111	.421	.091	.223	.262	.083	.169	.203			
C	.101	-.283	-.245	-.439	-.277	-.441	-.550	.200	.090	.315	.541	.107	.284	.266	.027	.133	-.078	.156	.190	.294		
COMP	.148	-.041	.012	.062	-.066	.084	.049	.027	.033	-.005	-.036	.039	.051	.110	.049	.051	.110	.178	.148	.062	.034	
M	92.51	12.74	8.98	9.02	12.35	15.07	7.37	24.38	17.54	18.82	19.46	20.31	23.00	17.14	17.59	22.27	16.95	21.33	22.44	51.14	55.33	69.36
SD	5.41	4.52	4.19	4.96	4.49	4.95	3.58	3.94	4.43	4.86	4.49	4.49	4.24	5.05	4.96	3.91	3.54	4.66	3.64	6.37	7.63	11.91

NOTES: N1 = Anxiety; N2 = Hostility; N3 = Depression; N4 = Self-consciousness; N5 = Impulsiveness; N6 = Vulnerability; E1 = Warmth; E2 = Gregariousness; E3 = Assertiveness; E4 = Activity; E5 = Excitement-seeking; E6 = Positive Emotions; O1 = Fantasy; O2 = Aesthetics; O3 = Feelings; O4 = Actions; O5 = Ideas; O6 = Values; A = Agreeableness; C = Conscientiousness

Table 18

Regression Analysis of Incremental Validity of Personality Over Aptitude in Prediction of ATCS Screen Performance by Sex

Step	Var	β	R	R^2	Adj-R^2	ΔR^2	ΔF	F (df)
				Men				
1	RATING[1]	.230	.230	.053	.051			29.34*** (1,527)
2	RATING	.220						
	E5[2]	-.132	.265	.070	.067	.017	9.86**	19.85*** (2,526)
3	RATING	.215						
	E5	-.147						
	O1	.094	.281	.079	.074	.009	4.92*	14.97*** (3,525)
4	RATING	.214						
	E5	-.173						
	O1	.101						
	E4	.086	.292	.086	.079	.007	3.84*	12.25*** (4,524)
				Women				
1	RATING	.148	.148	.022	.017			4.25* (1,191)
2	RATING	.133						
	O5	.167	.222	.049	.039	.028	5.53*	4.94** (2,190)

NOTES: [1]RATING was entered
[2]E5 = Excitement-seeking;
O1 = Fantasy;
O5 = Ideas;
E4 = Activity

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

DISCUSSION

Differences Between Controllers and General Population

Practical versus statistical significance. Overall, most of the comparisons between entry-level controllers of both sexes to their respective adult and college normative samples were statistically different. However, the relatively large sample sizes provided a great deal of statistical power, such that even very small, *practically* insignificant differences could be reliably detected. In this study, Tilton's *O* (1937) and the Common Language Effect Size (*CL*; McGraw & Wong, 1992) were employed to evaluate the practical magnitude of any detected statistical differences. Of the two, *CL* appeared to provide a more parsimonious description of differences by describing the number of occasions certain differences were likely to be observed in a random pairing of 100 cases from each sample. In general, the patterns of *t* test results combined with the overlap and effect size estimates indicated that women entry-level controllers were lower in neuroticism and higher on extraversion and conscientiousness than either the adult or college women normative groups, and that these differences were practically as well as statistically significant. Differences between men entry-level controllers and adult men were generally similar to those noted for women. Men controllers were expected to have higher *C* scores than adult men in 78 of 100 random pairings; in comparison, controllers were expected to have higher *E* scores in 99 of 100 pairings compared to a higher *N* score in only 9 of 100 such pairings. Entry-level men controllers were lower in neuroticism, openness to experience, and conscientiousness than college men. For example, men ATCSs were expected to have higher conscientiousness than college men in just 2 of 100 pairings, indicating that the statistical difference between men controllers and college men on the *C* domain was practically significant.

Profile interpretation

Given these apparent differences between controllers and normative samples, how would men and women controllers be described on the basis of the NEO-PI profile? Overall, ATCSs scored in the low-average range of the *Neuroticism* domain. Similar individuals might be seen as being generally calm and able to deal with stress; however, they would still experience a normal amount of disappointment and anger. The ATCS group, as a whole, had scores in the upper-range of the *Extraversion* domain. Individuals with these scores are cheerful, generally satisfied with life, and prefer excitement and stimulation along with the company of others most of the time. The *Openness to Experience* scores for these entry-level controllers suggested that they could be characterized as having broad interests, knowledgeable about many topics, and as being intellectually curious or investigative. The distribution of scores in the *Agreeableness* domain hinted that some ATCSs present themselves as generally warm, trusting, agreeable, and sympathetic to others while others present themselves as more tough-minded, skeptical, and competitive. ATCS group scores in the *Conscientiousness* domain were also in the mid-range. Such scores suggest that the entry-level controllers exhibit an average level of determination, reliability, and self-direction. Overall, the pattern of scores for men and women controllers suggested a certain level of intensity, energy, ambition or purpose, gregariousness, and generally good adjustment within this sample of controllers. Women entry-level controllers, in particular, appeared to be more dominant and forceful than their normative peers.

Conclusions about Differences Between Controllers and General Population

Persons who enter the FAA Academy ATCS Nonradar Screen program do differ from college students and adults on a number of personality dimensions as assessed by the *NEO-PI*. Differences were found generally on domain scales, with those differences being traced in some cases to specific facets within a domain. Those differences were similar for men and women controllers; controllers were more outgoing and had higher-levels of excitement-seeking, expressed more positive emotions, and were more conscientious than the normative samples.

Some of the differences noted above, however, may be attributable to the tendency for job applicants and employees undergoing evaluations to present themselves in a positive light. Previous research with the 16PF and ATCS applicants and job incumbents supports the presence of positive self-presentation (Karson & O'Dell, 1974; Schroeder & Dollar, 1989). However, the

differences between ATCS students and the normative groups were not evident across each of the dimensions or facets of the NEO-PI that one would expect to be sensitive to a positive test-taking attitude (*e.g., Agreeableness*).

Utility of Personality Measures

Selected aspects of personality also demonstrated incremental validity over cognitive measures in the prediction of performance in the FAA Academy ATCS Nonradar Screen program. Two of three facets that contributed to the final regression equation were drawn from the *Openness to Experience* domain. That finding is consistent with Barrick and Mount's (1991) conclusion that scores from the *O* domain were likely to be related to performance in training.

While the absolute amount of additional variance explained was small (2%), such marginal gains have significant utility impacts in large-scale selection systems such as that for controllers. For example, the increase in the proportion of employees considered satisfactory from the use of aptitude plus personality measures can be estimated using the Taylor-Russell tables (Taylor & Russell, 1939). Overall, about 60% of persons entering the Screen were successful. The current selection ratio, based on the cognitive aptitude ratings, is about .10. The validity coefficient of the cognitive aptitude rating by itself for this sample of men was about .23, and for women, .15. The validity coefficient for the combined group was .23. About 74% of the combined sample of men and women entry-level controllers would have been predicted to succeed in the Screen, based on interpolation of the Taylor-Russell tables. The validity coefficient for the cognitive aptitude rating plus personality facets was .29 for men and .22 for women, or about .27 for the combined sample. The interpolated predicted success rate for men and women would have been 77% if the NEO-PI scores had been used with cognitive aptitude scores in selecting persons to attend the FAA Academy. Overall, use of a combined personality-aptitude selection procedure would have resulted in net gain of about 3% in predictive efficiency, or approximately 30 additional developmental controllers (out of every 1000) being available to the FAA for field training.

The impact of that gain of 30 developmental controllers from a sample of about 1,000 entry-level controllers may not seem significant until placed in the context of the relative costs to the agency. The FAA Academy ATCS Nonradar Screen cost approximately $10,000 per student to administer (Aerospace Sciences, Inc., 1991). With about 2,000 candidates entering the FAA Academy each year, reduction of the failure rate by 30 controllers per 1000 candidates would have resulted in a savings of $600,000 per year in terms of wasted training resources. The total savings over the 5 full years of the ATCS Nonradar Screen's operational life would have been on the order of $3 Million in saved training resources. In other words, implementation of an ATCS selection test procedure with just marginal improvements in validity would have resulted in a significant savings to the agency.

Future Research Needs

The results presented in this paper provide some empirical counterpoints to the claim by Besco (1991) that personality measurement in selection programs for professional performance lack both scientific and practical value. Additional research is needed to provide further validation of these outcomes. Differences between entry-level controllers and the general population norms were found, with controllers being overall less neurotic, more extraverted and conscientious. Entry-level controllers reported few neurotic symptoms, appeared to exhibit better adjustment, and tended to be outgoing individuals with higher levels of excitement-seeking and more expressive of positive emotions. This provides a generally positive picture of those who apply and are selected to become operational controllers, and also suggests that they are well suited for handling the demands of a highly responsible job. These differences were in keeping with lay perceptions of the "controller personality," and supportive of research that suggests that certain occupations may attract individuals with different personality characteristics (Kassera & Russo, 1987). Additional research might investigate the relationships between personality and biodemographic factors, such as reasons for occupational choice and career expectations in the controller occupation.

Such research could provide the foundation for ATCS career guidance tools for use by aviation educators and agency recruiters.

The findings reported in this paper demonstrate that personality, as represented by scores on a theoretically-based and psychometrically sound instrument, explained additional variance in a technical performance measure beyond that explained by cognitive aptitude. It must be noted that this performance measure appeared to be uncontaminated by evaluative biases noted by Besco as fatal flaws in personality-oriented research. However, further research is needed to identify which aspects of the Screen program are most influenced by personality, such as the Instructor Assessment of student potential. While the observed relationships were small, it must be noted that our sample was a highly select group. Selection on the cognitive aptitude rating likely resulted in incidental restriction in the range of personality scores. It is probable that if the group were not initially selected on the basis of cognitive abilities, we would see a higher relationship between the NEO-PI scores and performance in the FAA Academy ATCS Nonradar Screen. In addition, further research is warranted on the interaction between personality and aptitude in performance to test the hypothesis that certain personality attributes may enhance or detract from performance for persons with high or low aptitude for the occupation. Finally, longitudinal research assessing the utility of personality measures in predicting performance across time is required. It is likely that the relationships between performance and stable personality traits change over time. The initial predictive power of personality dimensions may be low due to two factors: (a) variance in initial performance may be accounted for by ability and prior experience; and (b) as the "honeymoon", characterized by initially high commitment and effort, ends in a new job, the novelty and challenge in a job may fade and dispositional factors may become increasingly important determinants of performance (Helmreich, Sawin, & Carsrud, 1986). Both of these factors may account, at least in part, for the seemingly low observed personality-performance relations. Long-term follow-up studies will enable us to investigate changes in the personality-performance relations within the controller occupation.

References

Aerospace Sciences, Inc. (1991). Air traffic control specialist Pre-Training Screen preliminary validation: Final report. (Final report delivered to FAA under contract DFA01-90-Y-01034). Washington, DC: Federal Aviation Administration Office of the Deputy Administrator.

Aul, J. C. (1991). Employing air traffic controllers. In H. Wing, & C. A. Manning (Eds.). Selection of air traffic controllers: Complexity, requirements, and public interest. (DOT/FAA/AM-91/9). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.

Barrick, M. R., & Mount, M. K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. *Personnel Psychology, 44*, 1-26.

Besco, R. O. (1991). *The myths of pilot personality stereotypes.* Paper presented at the 6th International Symposium on Aviation Psychology, Columbus, OH.

Boone, J. O. (1979). *Toward the development of a new selection battery for air traffic control specialists.* (DOT/FAA/AM-79/21). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. [NTIS AD A080 065].

Buckley, E. P., O'Connor, W. F. & Beebe, T. (1969). *A comparative analysis of individual and system performance indices for the air traffic control system.* Atlantic City, NJ: Federal Aviation Administration National Aviation Facility Engineering Center (NAFEC).

Cascio, W. F. (1984). *Costing human resources: The financial impact of behavior in organizations.* Boston, MA: Kent Publishing Co.

Cattell, R. B., Eber, H. W., & Tatsuoka, M. M. (1970). *Handbook for the 16PF.* Champaign, IL: Institute for Personality and Aptitude Testing (IPAT).

Collins, W. E., Nye, L. G., & Manning, C. A. (1990). *Studies of poststrike air traffic control specialist trainees: III. Changes in demographic characteristics of Academy entrants and biodemographic predictors of success in air traffic controller selection and Academy screening.* (DOT/FAA/AM-90/4). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.

Collins, W. E., Schroeder, D. J., & Nye, L. G. (1989). *Relationships of anxiety scores to Academy and field training performance of air traffic control specialists.* (DOT/FAA/AM-89/7). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.

Colman, J. G. (1970). *Review and evaluation of present system for selection of air traffic controllers.* (Phase I, Task I Report submitted under Contract No. DOT-FA70WA-2371.) Washington, DC: Education and Public Affairs, Inc.

Costa, P. T. Jr., & McCrae, R. R. (1980). Still stable after all these years: Personality as a key to some issues in adulthood and old age. In P. Baltes & O. G. Brim, Jr. (Eds.). *Lifespan, development and behavior.* New York: Academic Press.

Costa, P. T. Jr., & McCrae, R. R. (1985). *The NEO Personality Inventory manual.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T. Jr., & McCrae, R. R. (1988a). Personality in adulthood: A six-year longitudinal study of self-reports and spouse ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology, 54,* 853-863.

Costa, P. T. Jr., & McCrae, R. R. (1988b). *NEO-PI/FFI Manual supplement.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., McCrae, R. R., & Holland, J. L. (1984). Personality and vocational interests in an adult sample. *Journal of Applied Psychology, 69,* 390-400.

Della Rocco, P. S., Manning, C. A., & Wing, H. (1990). *Selection of air traffic controllers for automated systems: Applications from current research.* (DOT/FAA/AM-90/13). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. [NTIS AD A238 267].

Dolgin, D. L., & Gibb, G. D. (1989). Personality assessment in aviator selection. In R. S. Jensen (Ed). *Aviation psychology,* p. 288-320. Brookfield, VT: Gower.

Deloney, J. R., & Schroeder, D. J. (1983). *Ways of perceiving the world and the relationship to success among air traffic controllers.* Presented at the 54th Annual Scientific Meeting of the Aerospace Medical Association, Houston, TX.

Eissfeldt, H. (1990). *The DLR selection of air traffic control applicants.* German Aerospace Research Establishment DLR, Hamburg, Germany.

Gough, H. G. (1960). *Manual for the California Psychological Inventory.* (Rev. Ed.). Palo Alto, CA: Consulting Psychologists Press.

Guion, R. M., & Gibson, W. M. (1988). Personnel selection and placement. *Annual Review of Psychology, 39,* 349-374.

Guion, R. M. & Gottier, R. F. (1965). Validity of personality measures in personnel selection. *Personnel Psychology, 18,* 349-374.

Helmreich, R. L., Sawin, L. L., & Carsrud, A. L. (1986). The honeymoon effect in job performance: Temporal increases in the predictive power of achievement motivation. *Journal of Applied Psychology, 71,* 185-188.

Hofstee, W. (1984). What's in a trait: Reflections about the inevitability of traits, their measurement, and taxonomy. In H. Bonarius, G. Van Heck, & N. Smid, (Eds.). *Personality psychology in Europe: Theoretical and empirical developments.* Lisse, the Netherlands: Swets & Zeitlinger.

Hogan, R. T. (1983). A socioanalytic theory of personality. In M. Page, (Ed.). *Nebraska Symposium on Motivation,* 55-89. Lincoln, NE: University of Nebraska Press.John, O. P., Angleitner, A., & Ostendorf, F. (1988). The lexical approach to personality: A historical review of trait taxonomic research. *European Journal of Personality, 2,* 171-203.

Karson, S., & O'Dell, J. W. (1969). *A criterion factor analysis of performance ratings and personality factors in radar controllers.* Paper presented at the Annual Scientific Meeting of the Aerospace Medical Association, San Francisco, CA.

Kassera, W., & Russo, T. (1987). Factor analysis of personality preferences and vocational interest. *Psychological Reports, 60,* 63-66.

Manning, C. A., Della Rocco, P. S., & Bryant, K. D. (1989). *Prediction of success in FAA air traffic control field training as a function of selection and screening test performance.* (DOT/FAA/AM-89/6). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. [NTIS AD A209 327/6/XAB].

Manning, C. A., Kegg, P. S., & Collins, W. E. (1989). Selection and screening programs for air traffic control. In R. S. Jensen (Ed.), *Aviation psychology,* 321-341. Brookfield, MA: Gower Technical.

Manning, C. A., VanDeventer, A. D., & Baxter, N. E. (1984). *Sensation seeking and performance in air traffic control specialist training.* Presented at the 55th Annual Scientific Meeting of the Aerospace Medical Association, San Diego, CA.

McCrae, R. R., & Costa, P. T. Jr. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology, 52,* 81-90.

McGraw, K. O., & Wong, S. P. (1992). A common language effect size statistic. *Psychological Bulletin, 111,* 361-365.

Myers, I. B. (1962). *The Myers-Briggs Type Indicator.* Palo Alto, CA: Consulting Psychologists Press.

Naylor, J. C., & Shine, L. C. (1965). A table for determining the increase in mean criterion score obtained using a selection device. *Journal of Industrial Psychology, 3,* 33-42.

Norman, W. (1963). Toward an adequate taxonomy of personality attributes. *Journal of Abnormal and Social Psychology, 66,* 574-583.

Nye, L. G., & Collins, W. E. (1991). *Some personality characteristics of air traffic control specialist trainees: Interactions of personality and aptitude test scores with FAA Academy success and career expectations.* (DOT/FAA/AM-91/8). Washington, DC: Federal Aviation Administration Office of Aviation Medicine.

Nyfield, G. R., Kandola, R. S., & Saville, P. F. (1983). *The Selection of air traffic controllers: Concurrent validity study.* London, England: Saville and Holdsworth Ltd.

Reilly, R. R., & Chao, G. T. (1982). Validity and fairness of some alternative employee selection procedures. *Personnel Psychology, 35,* 1-62.

Rock, D. B., Dailey, J. T., Ozur, H., Boone, J. O., & Pickerel, E. W. (1982). *Selection of applicants for the air traffic controller occupation.* (DOT/FAA/AM-82/11). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. [NTIS AD A122 795/8].

Rosenthal, R., & Rubin, D. B. (1984). Multiple contrasts and ordered Bonferonni procedures. *Journal of Educational Psychology, 76,* 1028-1034.

Schroeder, D. J. (1984). *Cognitive style and ATCS Academy pass/fail status.* Presented at the 55th Annual Scientific Meeting of the Aerospace Medical Association, San Diego, CA.

Schroeder, D. J., & Dollar, C. S. (1989). *Personality characteristics of pre/post-strike air traffic control applicants.* Presented at the 60th Annual Scientific Meeting of the Aerospace Medical Association, Washington, DC.

Seigel, A. I. (1978). Miniature job training and evaluation as a selection/ classification device. *Human Factors, 20,* 189-200.

Seigel, A. I. (1983). The miniature job training and evaluation approach: Additional findings. *Personnel Psychology, 36,* 41-56.

Seigel, A. I., & Bergman, B. A. (1975). A job learning approach to performance prediction. Personnel Psychology, 28, 325-339.

Sells, S. B., Dailey, J. T., & Pickrel, E. W. (Eds.) (1984). Selection of air traffic controllers. (DOT/FAA/AM-84/2). Washington, DC: Federal Aviation Administration Office of Aviation Medicine. [NTIS AD A147 765].

Smith, R. C. (1985). Stress, anxiety and the air traffic control specialist: Some surprising conclusions from a decade of research. In C. D. Spielberger & I. G. Sarason (Eds.). Stress and Anxiety. (Vol. 9, pp. 95-100). New York: Hemisphere.

Spielberger, D. C. (1979). Preliminary manual for the State-Trait Personality Inventory. Tampa, FL: University of South Florida, Human Resources Institute. SPSS, Inc. (1990). SPSS reference guide. Chicago, IL: Author.

Taylor, H. C., & Russell, J. T. (1939). The relationship of validity coefficients to the practical effectiveness of tests in selection: Discussion and tables. Journal of Applied Psychology, 23, 565-578.

Tett, R. P., Jackson, D. N., & Rothstein, M. (1991). Personality measures as predictors of job performance: A meta-analytic review. *Personnel Psychology, 44*, 703-742.

Tenopyr, M. L., & Oeltjen, P. D. (1982). Personnel selection and classification. *Annual Review of Psychology, 33*, 581-618.

Tilton, J. W. (1937). The measurement of overlapping. *Journal of Educational Psychology, 28*, 656-662.

Trites, D. K., Kurek, A., & Cobb, B. (1967). Personality and achievement of air traffic controllers. *Aerospace Medicine, 38*, 1145-1150.

Tupes, E. & Christal, R. (1961). *Recurrent personality factors based on trait ratings.* (Technical Report No. 61-97). Lackland AFB, TX: U.S. Air Force Aeronautical Systems Division.

United States Congress. (January 20, 1976). *House Committee on Government Operations recommendations on air traffic control training.* Washington, DC: Author.

Zuckerman, M. (1979). *Sensation seeking: Beyond the optimal level of arousal.* Hillsdale, NJ: Erlbaum.

*U.S. GOVERNMENT PRINTING OFFICE: 1993-761-068/60060